THE DEVELOPMENT OF THE SCIENCES IN KANSAS.

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Presidential address, delivered at Lawrence, December 1, 1905, before the thirty-eighth annual meeting of the Kansas Academy of Science.

IN preparing this address, the speaker has kept constantly in mind the needs and special interests of those who are beginners in scientific work or are actively engaged in exploring fields that are new and difficult. More than thirty years of science work in the schoolroom have fostered within him a most earnest desire to help in all scientific enterprises.

The membership of our Academy of Science has been nearly doubled during the past few years by reason of somewhat urgent efforts on the part of its officers and members. Similar efforts made during the past thirty-seven years of the existence of our organization have been attended with equal success, and so, undoubtedly, like efforts will be made during the future years of its existence.

Why should we attempt to increase the attendance at our meetings? Some of the answers that might be given would undoubtedly be the following:

1. All people should be in some degree naturalists, for they will thus have their hours of happiness largely increased.

2. The state needs more naturalists and scientists, for her industries must always be largely agricultural, horticultural and mining in their character, and the prosperity of farmers, miners and orchardists is in large measure dependent on our knowledge of minerals and of plant and animal friends and foes.

3. The schools of the state are giving a large place each year to nature studies and to natural-science subjects, and the teachers in the public schools must be more largely naturalists and scientists if they do this work successfully.

4. The pupils in the public schools need manuals containing serviceable keys of Kansas plants; Kansas insects; Kansas fish, amphibians, reptiles, birds, and mammals; Kansas crustaceans, mollusks, worms, hydra, sponges, and Protozoa; and Kansas fossils and minerals. These keys and natural histories should be prepared by Kansas naturalists and scientists under the auspices of this Acad-

emy or some similar organization containing men and women of large and varied experience in many fields of natural history.

5. A large membership gives the Academy a larger influence throughout the state and with the members of the state legislature. We are sadly in need of such recognition of the worth of our reports and of our library and museum, that abundant appropriations may be easily forthcoming.

6. The attendance at common meeting-places at stated times of large numbers of men of science would enable the Academy so to divide its work as to make it possible for those engaged in similar lines of investigation to meet in sections, and thus enable naturalists, scientists and philosophers to learn by personal conference what is being done in related lines of research.

7. With many contributors to their pages, the Academy could issue more valuable volumes of proceedings and a series of monographs on special subjects.

These seven reasons why we should continue to work for a larger membership to the Academy could easily be extended to several more, but those named will serve as an introduction to what it is desired to present for the favorable consideration of this audience. It is not intended to discuss the propositions embodied in the reasons just given in the order in which they have been presented, but an effort will be made to discuss them as they find place in the orderly unfolding of the subject of this address: The Development of the Sciences in Kansas.

On September 1, 1868, a number of lovers of nature gathered at what is now Washburn College and organized themselves into the Kansas Natural History Society. The name was well chosen, for its members were truly naturalists, and as such have done work of the highest value for themselves and the state.

If those of our members who have made collections of natural-history specimens and data will remember the experiences of collecting trips, or those attending investigations in the laboratory, they must declare that this work has brought more hours of happiness than almost any other that has engaged both hands and minds.

The speaker's own most persistent work as a naturalist has been done in collecting fossils, though insects, birds and plants have been collected with almost equal pleasure.

There is great delight in going through one's collections to feast one's eyes on some rare forms possessed by few others. Each time the hand rests on the specimen there is experienced anew the wild delight that was present when there was first found a specimen of

Eurypterus pachychirus, *Petalodus alleghaniensis*, or *Hydreionocrinus kansasensis*. Each detail of each great find is indelibly stamped on the memory. The only moments of regret come when it is remembered how the unfortunate individual who has been so indiscreet as to ask about the collections has been bored as the rare things have been brought out, their possessor forgetting that the poor victim knew little or nothing of what he was pleased to show him, and that he cared even less.

As a teacher of the sciences anxious to discover the best ways of presenting the subjects that belong to his department, the speaker has asked himself and others, Why do naturalists value their collections so highly, and why were most scientists first naturalists?

A glance through the reports of this Academy would make one marvel at the amount of space taken by lists of species contributed by its members, were it not known by personal experience that naturalists prize their collections even more than they do the knowledge that this or that species of plant or animal is a friend or a foe to the farmer, orchardist, or gardener.

In the first volume of proceedings issued by this Academy there is found a catalogue of plants, by J. H. Carruth, with additions by F. H. Snow and E. Hall; a catalogue of birds, by F. H. Snow; and a collection of facts on the climate of Kansas, by F. H. Snow. The lists show that great care had been taken to make them as complete as possible. They occupy more than half of the space of the volume, and must have been very helpful to other naturalists. The succeeding eighteen volumes are almost equally rich in lists of species—in all, more than ninety different lists. Of these, flowering plants furnish nearly one-third of the list, and, in the order named, Coleoptera, birds, minerals, fossils, Lepidoptera and some twelve or thirteen other groups the remainder.

To these lists of species should be added numerous lists of facts of observation and experiment. These comprise numerous references to work done in chemistry, physics, meteorology, mathematics, field geology, astronomy, psychology, and philosophy.

To show still further the intense interest of naturalists in collecting, a few members of the Academy have been asked to give, for use in this address, the number of species represented in their private collections.

Mr. Warren Knaus, of McPherson, reports that he has collected or obtained by exchange, since 1880, 5512 species of Coleoptera, distributed among 38 families.

Prof. Alfred W. Jones, of Salina, says that during the past ten

years he has collected 250 species of fossil plants from the Dakota sandstone; 30 invertebrate fossils from the Mentor Beds, of which 8 were new to science; and 300 species of marine and fresh-water shells.

Mr. B. B. Smyth writes me that the state collections under his charge at Topeka contain the following numbers of species and specimens:

	Species.	*Specimens.*
Birds, Goss collection	768	1,680
Birds, state collection	313	412
Mammals	34	40
Fishes, Popenoe and Smyth	78	80
Reptiles, Popenoe and Smyth	33	42
Insects, Snow and Popenoe	889	3,713
Herbarium, Smyth	1,860	5,600
Conchological collection, Quintard and Smyth	640	5,250
Totals	4,310	16,817

Mr. F. F. Crevecœur, of Onaga, Kan., reports the following very interesting miscellaneous collection:

	Species.	*Specimens.*
Birds	150	150
Mammals	9	11
Snakes	4	12
Lizards	4	15
Frogs	4	6
Fishes	2	4
Fossils	46	150
Plants	350	500
Archæology	2	3
Birds' eggs	54	300
Crustacea	15	30
Arachnida	21	50
Neuroptera	.38	70
Orthoptera	47	90
Diptera	137	275
Hemiptera	383	750
Hymenoptera	506	1,000
Lepidoptera	630	1,260
Coleoptera	4,100	9,450
Totals	6,502	14,126

Prof. Theo. H. Scheffer, of the State Agricultural College, Manhattan, one of our authorities on spiders, reports 160 species in our state, 4 or 8 species of daddy-long-legs, and 1 species of scorpion.

Our most inveterate collector of vertebrate fossils is Mr. Chas. H. Sternberg, of Lawrence. His more than thirty years of experience in digging and restoring skeletons is probably unequaled in the United States.

Largely while in company with Dr. F. H. Snow, the following collection of insects was made by Eugene Smyth, a young man only nineteen years old:

	Species.	*Specimens.*
Diptera	80	230
Hymenoptera	148	380
Neuroptera	28	90
Orthoptera	75	215
Lepidoptera	122	350
Hemiptera	84	208
Coleoptera	2,196	17,678
Totals	2,733	19,151

Prof. F. B. Isely, of the Wichita high school, has in his collection 127 species of Kansas Orthoptera, as well as quite a number of species representing the other orders of insects.

But the monumental work of Dr. F. H. Snow, the oldest in membership and the most persistent collector of this Academy, is probably without an equal in the entire western hemisphere, if not in the whole world, when we consider the personal character of this work. Of insects, Doctor Snow reports:

	Species.	*Specimens.*
Coleoptera	9,060	63,000
Lepidoptera	3,750	10,000
Hymenoptera	2,050	10,500
Diptera	3,340	28,000
Orthoptera	300	1,500
Neuroptera	200	1,000
Hemiptera	500	5,000
Kansas spiders	55	500
Myriapods	45	250
Miscellaneous	200	1,000
Totals	19,500	120,900
Collected in 1904-'05	1,500	50,000
Making a grand total of	21,000	170,900

The account of Doctor Snow's work as a naturalist is still incomplete, for, in addition to his collection of insects, should be counted his early work on plants, his collection of meteorites, his list of Kansas birds, his accumulation of data bearing on Kansas weather, and his boxes of fossils, that he has been too modest to enumerate.

It was the hope of the writer to be able to give several other lists of collections made by members of this Academy, but the data were not received in time for this paper.

Your speaker's own craze for collecting has led him to load his cabinets with fossils; and he is very proud of the fact that he has collected fossil invertebrates and vertebrates from Massachusetts

to California, and in every rock group from the Potsdam sandstone to the Tertiary—in all, 700 or 800 species of fossils and 200 or 300 species of rocks and minerals.

The search for natural-history specimens is but one of the many forms of the collecting activity. As the speaker observed in a paper read at the Manhattan meeting of this Academy, the love of collecting is well-nigh universal, and the usefulness of the thing collected has little influence with the collector. To get something some one else has not, or something that is handsomer than that possessed by another, is balm to the feelings, and is inherent in all life tendencies, whether of man or of the lower organisms.

Modern psychology teaches that the mainspring of the will lies in the feelings and emotions, and not in the intellect, as was once believed. We do what we desire, not what the intellect advises. The student of social ethics has long since learned that the feelings aroused by possession and by rivalry are most potent in determining conduct. This is explained by the scientist who has formulated theories concerning heredity, by affirming that the feelings aroused by possession and rivalry are racial in their character, and are, therefore, inherited, subconscious tendencies in the individual; and that this is why they are so powerful in determining what we shall or shall not do.

To illustrate the power of these subconscious tendencies over the individual who chances to be a naturalist or even a collector of mere curiosities, please try to imagine the correct answers to the following questions: Why should Doctor Horn pay fifty dollars for a single beetle? What was there about a tiger-beetle, the *Amblychila cylindriformis,* that was so valuable or interesting that the museums of Europe and America were anxious to pay Doctor Snow twenty-five dollars a head for them? What is there about a tropical butterfly that should cause collectors to pay $100 or $200 for a single specimen? And why should millions of dollars be invested in canceled postage-stamps by stamp collectors in Europe and America?

Those who have never made a collection, save of silver, gold or paper dollars, who have never turned their racial collecting tendencies in the direction of natural-history specimens, find it nearly impossible to understand why such work as that performed by Doctor Snow has such a powerful attraction for naturalists.

One summer Louis Agassiz, then at the height of his fame as a public lecturer and as professor of zoology at Harvard, spent several weeks collecting in Vermont. A gentleman wishing to see

him inquired of a farmer if he had seen Professor Agassiz that morning. The farmer looked up from his work in surprise, and told the gentleman that Louis Agassiz, the great naturalist, lived at Cambridge, Mass., and that he guessed he would have to go there to find him. "There are no strangers here," the farmer added, "except a crazy old Dutchman who is over in the field yonder catching butterflies and bugs." The thrifty collector of lucre felt no affinity for a "Dutchman" catching insects.

One's ability to appreciate the collections of another seems also to stand in direct ratio to his stock of general information.

Soon after the civil war General Custer led an exploring expedition to the Black Hills. On the invitation of the government, several eminent men of science accompanied the troops. As the Sioux Indians were then very hostile, and the men of science insisted on making side trips for the purpose of collecting natural-history specimens, each scientist was attended by a guard of six soldiers, much to the discomfort of the latter and the inconvenience of the former. One day the most persistent collector escaped from his guard of soldiers and wandered off into the hills, where he was quickly pounced upon by the Sioux. The Indians thrust their hands into his pockets and collecting bag for plunder, and were disgusted to find that they contained plants, fossils, lizards, and other material dear to the heart of a naturalist, but worthless trash to Indians, and were exceedingly puzzled to know what sort of man they had captured. While the savages were discussing the nature of their queer captive, the naturalist saw a rare butterfly, and, forgetful of everything else, started off on a run to effect its capture. He soon returned and proudly exhibited his prize to the Indians. This decided them, and the chief took him gently by the sleeve, led him to a distant ridge, and pointed the way to Custer's camp. The Indians had concluded that the naturalist was insane, and thus, according to their belief, was under the special care of the Great Spirit; otherwise he would have been put to death for invading their country.

The farmer thought that the naturalist was spending his time foolishly; the Indians believed that he was crazy; and it is not sure but that each one of us thinks that the other naturalists would show better sense by collecting our specialty.

I have dwelt thus fully on the deep, unreasoning love with which a collector regards the specimens in his own cabinet, in part to make plain the cause of certain serious mistakes made by naturalists in publishing, as interesting matter to the world in general, the results of

their labors, mistakes which have been repeated by too many science teachers in the classroom.

Lists of plants, insects, and other invertebrates, fish, amphibians, reptiles, birds, and mammals, and detailed sections of geological strata, with lists of the included fossils, are of most interest and value to the one who made the list or section, are of some value to a few specialists, and are of no interest or value to the general reader. In the classroom their value is the same as that of the algebraic quantity, x.

Tons of scientific reports are gathering dust in private and public libraries because 99 readers out of 100 care nothing for them. Lists of species of plants, shells, insects, vertebrates, fossils and minerals are seldom read save by those who desire to make exchanges and who are enthusiastic collectors.

Editors of periodicals intended for the general reader have learned by severe experience what matter pleases their patrons best. I quote the following from an advertising circular issued by the New York *Independent:* "There is a prevalent belief among editors that the average reader hates science and will turn against any journal which attempts to force it down his throat. Nevertheless, we regard it as much our duty to get accurate, authoritative accounts of discoveries in science as it is to record a battle or a royal marriage."

We all know that the *Independent* is right, and the inference is plain. All reports of scientific work to be read by a willing public should be issued in two or three parts. One part might contain the detailed account of experiments performed, uninteresting save to the specialist; the long story of how the observations were made, interesting chiefly to the one who made the observations; and the long lists of names of the specimens collected, valuable mostly in making exchanges and in exciting the envy of other collectors. The second part could be made to show what great and valuable truths had been learned by experimentation or field observation, and how the species collected are related to man's welfare or may be made to contribute to his comfort. A third part should be prepared so as to be of assistance to students and to all others who desire to become naturalists. It should provide some easy method of learning what naturalists have discovered and of getting the scientific names of species of minerals, plants, and animals. To this end, natural-history manuals provided with easily understood keys and glossaries ought to be provided for the use of young naturalists and others little skilled in determining species.

The United States Geological Survey and the state experiment stations, after years of trial, have decided to publish two distinct series of bulletins and monographs, one for specialists, and the other for those interested in the economic work of the survey and the experiment stations in the several states.

While the United States Geological Survey has not as yet seen fit to issue manuals and keys for the ready determination of fossils, minerals, and rocks, the Smithsonian Institution has published in its reports several exceedingly valuable papers containing keys to species which have been very helpful to naturalists. Some of the monographs issued by our Kansas University have served excellently the same purpose.

Our own volume of proceedings is perhaps too small to admit of sharp classification of the papers on the basis of their scientific or economic value; but the lists of species and similar bald enumerations of data might be published separately, in pamphlet form, for the use of specialists.

Your speaker is confident, ladies and gentlemen of the Academy, that we shall receive larger favors from our state legislature when we in our explorations and reports pay more attention to the economic and educational interests of the people of Kansas.

It is a generally accepted truth that naturalists love their work, love its exact methods, love its honest conclusions; that they love their work more than they do their own comfort, more than they do money, and even more than life itself; and that they are seldom guilty of seeking wealth dishonestly. But, from the nature of their inherited subconscious tendencies, naturalists are not altruists. They may love the collections of another, but not the collector.

It is said of one of our most eminent paleontologists that it was never safe to leave him alone with the fossils of another unless they were in drawers and the drawers were locked.

It is certainly right to love our collections, to love our science work; but it is also certain that we need to specialize in the direction of economic value and educational value more than ever before, both because it is right, and because the people, the legislatures and the men of wealth properly refuse money for scientific surveys and scientific institutions unless the work promises to be of direct as well as indirect value to the people at large. The sudden ending of many natural-history surveys at the hands of state legislatures and the difficulty of getting appropriations for most scientific purposes should convince the most inveterate collectors that they

owe something to others as well as to themselves and their collections.

The interests of the schools lie in the same direction as the interests of the people. In days past we have been guilty of thinking that names and classifications and a little morphology, with a modicum of internal structure, were all that any student would care to know about our insects, birds, fossils, and plants. But modern and wiser science teaching demands that pupils get a knowledge of fewer things discovered by others and of more things learned by their own efforts. Knowledge in its dynamic forms, rather than information in a static condition, is what the schools need; hence the text-books must be suggestive, stimulating, and healthful, rather than satisfying. The students must be induced to collect largely and widely, both objects and information, in the field, in the laboratory, and in the library. They need to know a little of how others collect and what they discover—just enough to serve as a stimulus to personal effort. As all know, every day of the student's life must be fruitful of results; days must not pass in fruitless waiting, as is the experience of most naturalists in field and laboratory. Hence, manuals giving the essentials of what is known of each form of life of economic and scientific importance, and of each valuable rock and mineral, keys for the easy identification of every species known in Kansas and suggestions opening the way to valuable lines of inquiry should be accessible to every student and young naturalist in our state, and should be prepared by our most capable men of science.

It is exceedingly unfortunate that many teachers should feel that the items of information contained in physiologies and in old-fashioned natural histories are so important that they should be memorized by their pupils in a purely mechanical way. The results are of course disastrous. No wonder the sciences as taught in many of our high schools and in the grades are disliked by the pupils and are barren of valuable outcome. You who have read examination papers from these schools may perhaps remember some of the wonderful items of misinformation secured by this cramming of valuable facts of experience gathered by another.

A few samples of these misfit groups of unrelated ideas, gathered from sources that shall be nameless, are given as illustrations: "The alligator is the largest insect of North America." "Trypsin changes indigestible food into proteid." "The undigested food goes to the gall-bladder." "Things that are equal to each other

are equal to anything else." "The corniferous limestone is a rock in which fossil corn is found."

Thus far there have been considered the work, responsibilities and duties of the naturalist.

The work of the scientist may properly be considered next, for he follows the naturalist in line of ascent. Natural history becomes natural science when its facts are arranged in an orderly way, or so as to show laws of sequence and underlying principles. The scientist is the one who classifies the facts of observation so as to reveal underlying and related principles, and evolves from the observations and principles his great inductions in the form of theories respecting heredity, cell activities in plants and animals, social economics, the formation of the earth, the constitution of atoms and molecules, the development of the great religions, the origin of plants, animals, and even man, and observed facts in many other lines of research.

Perhaps the wonderful discoveries of truth made by the naturalist-scientist are due in large measure to his remarkably exact classifications of what he has learned by observation, experiment, and reading. While these classifications have yielded rich returns in new truths, both during their construction and in their completed form, they have also served a most important use in directing the investigations of students along fruitful lines of research, and in opening the way for mechanics and inventors to discover new ways in which known forces may be harnessed for the use of man.

While the labors of scientists have brought untold wealth to our industries, they have resulted in mixed blessings to our schools, colleges, and universities.

The scientist so loves his classifications and theories that he is loth to have them materially modified. In the classroom he is very apt to teach that they embody the whole truth and nothing but the truth. As a consequence his pupils become non-receptive to even obvious inductions of new truth.

Luther Burbank has tried to work with university graduates on his world-renowned farms at Santa Rosa and Sebastopol in his plant-breeding experiments, but he has never been able to keep in service a single university student. "Time and again some enthusiastic young fellow," according to W. S. Harwood in "New Creations in Plant Life" (page 138), "would enter upon the work, and, bred to the nomenclature and traditions of the scientists, would at once begin enlightening Mr. Burbank on the best plan to follow in a given instance, forgetting that the silent man patiently listening to him stood at the head of the plant-breeders of the world."

Used properly, the inductions, hypotheses, classifications and theories of the scientist have, as we all know, high educational value. Even the classifications, the most formal of all the work of the scientist, serve an excellent purpose in training students.

Some classifications of ideas or names, such as those found in the dictionaries and cyclopedias, are too simple to be in themselves valuable factors in education, but many of the classifications of animals, plants, minerals and chemicals are so exact in the use of terms, and are so complex in structure, that no student can run down to its appropriate species any specimen in natural history without having previously made a careful study of the form to be classified. The classification of plants in Gray's "Flora" has served as a stimulus to exact observation to a generation of amateur botanists, and so have similar works on vertebrates, birds, and insects.

I do not need to advocate in this presence the cause of the schoolmaster who wishes to make better naturalists and scientists of his pupils; but I fear, sometimes, the most of us need to be urged to make more strenuous efforts in this direction.

With a view to throwing light on the problem of conflicting evidence in court-rooms, Professor Von Liszt, of Berlin, Germany, arranged a quarrel between two of his students, the other twenty-three to have no suspicion that the event was planned.

At the appointed time the quarrel took place, amid tremendous excitement. The professor finally put a stop to it. A week later he lectured on "Evidence," having in the meantime taken the testimony of all those who witnessed the quarrel. Out of the twenty-three well-educated young men, the testimony of no two was exactly alike. No fewer than eight different persons were named as the originator of the fight, in which, actually, but two had been concerned.

The actual firing of a pistol was accurately described by nearly all, but there were four separate versions of the period of the quarrel at which it was fired. The professor's way of quelling the disturbance was described in eight different versions.

"You are like most persons," Professor Von Liszt told his students after reporting the result of this inquiry. "You look, but you do not see. It is not wilful perjurers who impede the course of justice—such persons are few—but careless people like yourselves, who have not trained the eye to report to the brain accurately what it beholds."

Throughout the major portion of the work in botany at the State Normal, students are asked to report what they see and not

what they infer; and yet this rule is unintentionally violated from one to three times, on the average, during each recitation. The students prepare in class detailed descriptions of plants they are studying, and then determine the species by using Gray's "Flora" with its several keys. After each statement of a characteristic in the key the student must pronounce judgment, subject to the criticism of the class and teacher. In this way the students are led not only to observe closely, but also to cultivate the habit of truth-telling, a practice that is exceedingly rare even in brief conversations. The ability to classify a specimen, while in itself a pleasure, also doubles the pleasure of collecting, as all know who have tried it, and greatly increases the range of objects collected.

As before stated, the young naturalists of Kansas sadly lack keys to Kansas specimens, and manuals describing their habits or qualities and economic importance.

Now that the members of this Academy have prepared fairly complete lists of the mamals, birds, reptiles, amphibians, fish, insects and other invertebrates; and of the algæ, fungi, mosses, ferns and flowering plants of Kansas, why, as before suggested, may not this Academy, through special committees, take up the work of preparing natural histories of our animals and plants, each history having its working key to the groups described? Other states have prepared these manuals with predominant economic features, and why may not Kansas? It must be done largely as a work of love; but a wonderful impetus would thus be given to the study of the sciences by the members of this Academy, by the students in the various schools of the state, and by independent workers throughout Kansas.

The third and highest stage in the development of the sciences is that of philosophy, a stage in which we love wisdom for its own sake; where man comes nearest "to thinking the thoughts of God after Him."

When naturalists have collected an abundance of data from the various fields of research among the myriad forms of plant and animal life; when scientists have classified these data in all possible ways, using, for instance, as bases, form, structure, food-getting habits, modes of offense and defense, tendencies to variation, methods of development from the fertilized egg, and the lines of development of the fossil forms dug out of the crust of the earth; and when master scientists shall have taken these classifications of the observed facts, and all the hypotheses and theories of science, and shall have sorted and arranged them with due regard to perspective,

then observation towers will be erected, with tops lifted so far above the bewildering maze of the myriad facts of observation that wide surveys can be made of the dominant truths of God's universe, and heaven-reaching generalizations be made by these master scientists, the true philosophers.

The scientific method of research provides that deduction shall follow, not precede, induction. The visions of truth, the inductions of the scientist-philosophers, help wonderfully in rectifying the work of the systematist, and in showing the naturalist where to observe, where to experiment, and where to collect.

This world does not need more potential energy so much as it needs to know how to transform more of it into useful forms of kinetic energy. So in the formation of the collecting habit, we do not need to urge more people to make collections, but we do need to urge more people to make collections that are valuable, that are useful.

It is to be deplored, for instance, that sane men and women should use valuable time in making collections of buttons, tobacco tags, old shoes, luggage labels, and postage-stamps. Not only do such collectors waste time and effort on their collections, but they also waste energy in the form of hard cash. One European collector was so dominated by the subconscious craze for the possession of rare specimens that he paid $3500 for a poorly printed two-cent stamp issued some years since by Hawaii. A blue stamp issued by a Baltimore postmaster before our general government took charge of the mails sells for $4400, and a one-cent stamp issued by Mauritius in 1847 sold recently for $4840. A Confederate silver dollar is valued at $1500, and one issued by the United States in 1804 is quoted at $1000. This craze for rare things assumes a psuedo-literary phase when collectors offer $8000 for an eighth-century manuscript of Homer's "Iliad," $6450 for the original manuscript of Scott's "Lady of the Lake," and $5250 for the autobiography of Lord Nelson in his own handwriting.

Even natural-history specimens bring absurdly high prices. A Rocky Mountain prospector ate for breakfast six eggs of the Yellow pheasant, and learned ten minutes later, to the discomfort of his digestive organs, that the eggs were worth exactly $100 each. At the time of the tulip craze in Holland, hundred-dollar tulip bulbs were common, and thousand-dollar bulbs not uncommon.

The inductions of the scientist-philosopher also serve a most excellent purpose in correcting the imperfect inductions of the scientist. It is said by G. H. Lewes that Herbert Spencer was

not so much a naturalist or scientist as philosopher; and yet his philosophic grasp of first principles enabled him to correct his friend Huxley, one of the greatest of comparative anatomists, and Hewlings Jackson, a very eminent authority on the pathology of the nervous system, in some questions of fact respecting the comparative anatomy and pathology of the cerebellum.

Spencer had had very limited opportunities for studying the comparative anatomy of animals; but his mind, skilled in philosophy, had seized and retained the essential facts of comparative anatomy as they were presented to him in conversation, in the course of his reading, and in his limited opportunities for observation, and he was thus enabled to correct specialists in their own fields of research.

These remarkable powers of the scientist-philosopher seem at times almost miraculous to those uneducated in scientific methods. He tells the astronomer where to point his instrument to discover a new world. The astronomer obeys and, behold, it is there! Or he tells the chemist that elements of certain atomic weights are needed to fill gaps in the arrangement of the elements according to the periodic law, and the chemist goes to his laboratory and finds them.

In a paper read at the Topeka meeting, objection was made by your speaker to the attempts of certain biologists to make biology a mathematical science, as are physics, chemistry, and astronomy. It was declared in the paper that the mathematician is concerned with the investigation of certain exactly statable postulates or hypotheses; that in biology, on the contrary, the one who uses the method of the mathematician can meet only with wrong results, for life obeys no law other than its own highest good, and this cannot be stated in mathematically exact terms. If the following paragraphs taken from *Science* are true, the above statement seems to need modification.

In *Science* for August 11, 1905, Dr. George Bruce Halstead, of Kenyon College, Gambier, Ohio, discusses the relationship of biology to the new mathematics, the mathematics that has given us the non-Euclidian geometry. I quote from this article. Doctor Halstead says:

"Thus, as the Russian, Alexeieff, has pointed out, after the continuity world scheme had captured the fundamental natural sciences —geometry, mechanics, astronomy, physics, chemistry—had entrenched itself in them and dowered them with generality, uniformity, universality, it went over gradually with scientific investigators,

by habit, so to say, into flesh and blood, and began to penetrate and dominate in physiology, in psychology, in sociology, in biology. . . . So we have the doctrine of a fatalist causality, denial of efficient freedom of the will, belittling of the idealistic endeavor of mankind; hence the pessimistic attitude toward the whole of human existence. . . . But the latest advances in mathematics have rendered unnecessary for biology the wearing of this misfit garment.

"The new mathematics gives now a standpoint for the explanation and treatment of natural phenomena from which the biologic elements need not be suppressed. . . .

"The continuity thought way strives to reduce all phenomena of nature to a general mechanism with fate-determined movement. Just contrary to this, then, is the view that living nature is a rationally correlated realm, in which everything is harmonic, shows adaptation, strives toward perfection."

This discovery that discontinuous variation in biology is in accord with non-Euclidian mathematics relieves students of life problems from the necessity of declaring that the method of studying the life sciences differs widely from the method of studying the mathematical and physical sciences. Darwin tried to conform in his great theory of evolution to the Euclidian continuity theory of mathematics; but the occurrence of sports among plants and animals was fatal to his theory of continuous variation. Darwin's appeal to natural selection to account for wide gaps in the ranks of plant and animal species also failed, for nature could select or reject only what life offered; and life has always persisted in offering those forms of individuals which contain parts possessed by generations of ancestors, and rarely a form with a few parts, found, perhaps, in one individual in a million, never before found on earth. These individuals, those given the new structures, and called sports or mutations, cannot be accounted for by peculiarities of environment, for they and the environment may or may not agree.

Burbank's experiments in plant-breeding have demonstrated that each species is the sum total of all past strains of heredity more or less modified by their interaction. When several species are crossed by pollination, no man knows what may be the outcome. In 100,000 hybrids produced by such crossing, Mr. Burbank found all shades of intermediate characters and many new ones. Selecting from these hundreds of thousands of hybrids those that possessed the qualities he desired, and destroying the rest, Mr.

Burbank has obtained dozens of new forms of fruits, flowers, and forage plants. By hybridization and selection he has been able to change, almost at will, old hereditary instincts and obtain the new ones he desired. Slightly modifying Mr. Burbank's statements respecting his work, he may be said to have found in his ten or fifteen years of wonderful experimentation that the powers possessed by life are the resultant of a mixed heredity from thousands of ancestors, and are, and have been, modified by life to better meet the conditions imposed by environment.

Thus the observations of Burbank as to what constitutes the true mainsprings of variation have still further emancipated life from the Darwinian, materialistic, continuity theory of variation. Thus enthroned in the thoughts of modern scientists, life may now be studied as she manifests herself in myriads of living forms, produced at her own sweet will and varied at pleasure, without invoking any tropism theory to account for her activities, or any Weismann germ plasm theory, or any Mendelian law, to limit her power to transmit her qualities or to vary them in her descendants by her own conscious powers.

Untrammeled by olden-time restrictions, the study of life has progressed by leaps and bounds. The now universally accepted theory of evolution requires that all life activities on earth shall follow one another in a definitely established order: (1) The simple shall precede the complex; (2) the variable shall end in becoming stable; (3) new characters shall be added to the old, and may overshadow and obscure them.

All evolutionists, therefore, may believe that the first activities of life were simple and variable and were consciously performed. By repetition, these in the individual, then as now, became habits. These habits persisted in by individuals for a series of generations became hereditary, subconscious activities, belonging to the species or race. And these, in turn, when they had lost the conscious element, became race instincts.

This generalization made necessary in teaching biology with life as the dominant influence has relieved the classroom of a world of trouble in explaining the relationship of reason to instinct, and of both to subconscious activity.

For example, if we regard nest-building as a subconscious activity all difficulties of explanation vanish. The tendency to build nests is instinctive and hereditary, while the act of building the nest is consciously performed and may be varied at the pleasure of the bird, as observation teaches.

In like manner we may readily explain other activities of the lower animals, such as migration of birds, ascent of rivers by fish to deposit their spawn, and all other provisions for food getting and care of young by both vertebrates and invertebrates.

The origin of instincts from subconscious activities, and these from habits and conscious activities, is a generalization in harmony not only with the doctrine of evolution, but also with the latest teachings of biologic psychology, and it denies in a very pronounced way the prevalent discordant and inharmonious theories of the materialistic biologists and psychologists.

There has been considered here the pleasure attending the work of the naturalist and scientist; that his pleasure is of the earth, earthy, compared with that which comes to the scientist-philosopher when he makes broad surveys of the fields of truth to the farther limits of God's universe.

The pleasures of the naturalist arise from the possession of things that are wonderful or rare. It has its mainsprings in an inherited, subconscious self, and is therefore deeply egoistic. The scientist may take great delight in building his classifications and in being regarded as an authority in his special department of science work; but the naturalist and scientist like best to be alone in their labors, for they demand personal credit for their collections and generalizations. On the other hand, the richer enjoyments of the philosopher arise from companionship in the search for truth, and from the contemplation of that which will bless all mankind in its fruitage.

In conclusion, it is desired to emphasize one or two things said in this address. As an Academy of Science for the state of Kansas, it is believed that it is a duty which this organization owes to the state to assist through its members more young people to become students of science, and to make our observations and experiments as naturalists, our conclusions and classifications as scientists and our broad generalizations as philosophers contribute more largely in the future than in the past to the industrial, social, intellectual and spiritual happiness of the people of our commonwealth. To this end it is hoped that the means suggested for the more ready study of the minerals, plants and animals of our state will soon be provided by the members of this Academy, either as such or as members of the faculties of our higher institutions of learning.

MUSEUM (looking west).